while on the floors of the spots, here and there, were similar single cloud-masses, the distribution of which varied from time to time, the spectrum of these masses resembling that of their fellows on the general surface of the sun.

I have before stated that the region of a spot comprised by the penumbra appears to be shallower in the spots I have observed lately (we are now near the maximum period of sun spots); I have further to remark that I have evidence that the chromosphere is also shallower than it was in 1868.

I am now making special observations on these two points, as I consider that many important conclusions may be drawn from them.

DESCRIPTION OF PLATE III.

Mr. Holiday's drawings and remarks.

1. Prominence much bent.
2. Prominence encroaching over limb—bright line crossing black line.
3. Black line (F) curved downwards, sometimes nearly touching iron line below.
4.
5. Prominence nearly divided.
6. Intensely brilliant flashes above and below centres (of F lines); the interruptions very complete.

7 & 8. Curves in prominence very marked.

9, 10, 12, 14, 15. My own drawings, made during first and second outbursts.

11. A lozenge on the limb as seen with a tangential slit.

13. A lozenge as seen on the sun itself.

VII. "On some Elementary Principles in Animal Mechanics.—No. IV. On the difference between a Hand and a Foot, as shown by their Flexor tendons." By the Rev. Samuel Haughton, F.R.S., M.D. Dubl., D.C.L. Oxon., Fellow of Trinity College, Dublin. Received April 23, 1870.

The fore feet of vertebrate animals are often used merely as organs of locomotion, like the hind feet; and in the higher mammals they are more or less "cephalized," or appropriated as hands to the use of the brain.

The proper use of a hand when thus specialized in its action, is to grasp objects; while the proper use of a foot is to propel the animal forward by the intervention of the ground.

In the case of the hand, the flexor muscles of the fore arm act upon the finger tendons, in a direction from the muscles towards the tendons, which latter undergo friction at the wrist and other joints of the hand, the force being applied by the muscles to the tendon above the wrist, and the resistance being applied at the extremities of the tendons below the wrist by the object grasped by the hand.

From the principle of "Least Action in Nature" we are entitled to assume the strength of each portion of a tendon to be proportional to the force it is required to transmit; and since, in a proper hand, these forces are continually diminished by friction, as we proceed from the muscle to

the fingers, we should expect the strength of the tendon above the wrist to be greater than the united strengths of all the finger-tendons.

Conversely, in a proper foot, the force is applied by the ground to the extremities of the tendons of the toes, and transmitted to the flexor muscles of the leg, by means of the tendons of the inner ankle, which undergo friction in passing round that and the other joints of the foot. In this case, therefore, we should expect the united strengths of the flexor tendons of the toes to exceed the strength of the flexor tendons above the heel.

In the case of the hand, friction acts against the muscles; in the case of the foot, friction aids the muscles.

I have measured the relative strengths of the deep flexor tendons of the hand above and below the wrist in several animals, and also the relative strengths of the long flexor tendons of the foot above and below the ankle in the following manner:—

I weighed certain lengths of the tendons above the wrist and ankle, and compared these weights with the weights of equal lengths of the flexor tendons of the fingers or toes, assuming that the weights of equal lengths are proportional to their cross sections, and these again proportional to the strengths of the tendons at the place of section. The difference between the weights above and below the joint represents the sum of all the frictions experienced by the tendons between the two points of section.

The following Tables contain the results of my measurements:—

TABLE I. *Friction of Long Flexor Tendons of Toes.* (Cross section of toe tendons greater than cross section of muscle tendons.)

	Amount of friction. per cent.		Amount of friction. per cent.
1. Pyrenean Mastiff	65·4	17. Australian Dinjo	33·8
2. African Lion	59·0	18. Japanese Bear	31·7
3. Common Fox	57·6	19. Virginian Bear	25·9
4. African Jabiru	56·8	20. Common Llama	25·9
5. American Rhea	52·4	21. Hedgehog	25·0
6. Indian Jackall	49·2	22. African Ostrich	24·6
7. American Jaguar	49·2	23. Common Otter	19·8
8. New-Zealand Weka Rail	47·5	24. Man (mean of 5)	16·2
9. Silver Pheasant	47·4	25. Spider-Monkey	12·3
10. Bengal Tiger	46·0	26. Goat	9·5
11. Indian Leopard	45·5	27. One-horned Rhinoceros	9·0
12. Six-banded Armadillo	44·4	28. Negro-Monkey	8·0
13. Three-toed Sloth	42·5	29. Brahmin Cow	6·8
14. Black Swan	36·0	30. Nemestrine Macaque	2·0
15. Common Hare	36·0	31. Boomer Kangaroo	0·0
16. European Wolf	34·0		

The foregoing animals all realize the typical idea of a true foot, with a variable amount of friction at the ankle-joint; this friction disappearing altogether in the Boomer Kangaroo, whose method of progression realizes absolute mechanical perfection, as no force whatever is consumed by the friction of the flexor tendons at the heel.

The only animals whose feet deviated from the typical foot were three, viz. Alligator, Common Porcupine, and Phalanger. In these animals the foot has the mechanical action of a hand, or grasping organ; and the flexor tendons above the ankle exceeded those below the ankle by the following amounts:—

	per cent.
1. Alligator	11·5
2. Common Porcupine	20·0
3. Phalanger	29·2

In the case of the flexor tendons of the hand, I obtained the following results:—

TABLE II. *Friction of Deep Flexor Tendons of Hand.* (Cross section of muscle tendons greater than cross section of finger tendons.)

	Amount of friction. per cent.		Amount of friction. per cent.
1. Common Porcupine	71·0	8. Negro-Monkey	27·4
2. Sooty Mangaby	49·2	9. Spider-Monkey	26·5
3. Nemestrine Macaque	40·7	10. Bengal Tiger	22·7
4. Capuchin Monkey	35·3	11. Common Fox	20·7
5. Virginian Bear	35·0	12. Pyrenean Mastiff	7·0
6. European Wolf	31·4	13. Goat	0·0
7. Japanese Bear	30·6		

It will be observed that the fore foot of the Goat, regarded simply as an orrgan of locomotion, attains a perfection comparable with that of the hind foot of the Kangaroo, no force being lost by friction at the wrist-joint.

The only animal in which I found a departure from the typical hand was the Llama, in which the flexor tendons of the fingers exceed the flexor tendon above the wrist by 14·4 per cent.

The bearing of the foregoing results on the habits of locomotion of the several animals will suggest themselves at once to naturalists who have carefully studied those habits. I shall merely add that the subject admits of being carried into the details of the separate or combined actions of the several fingers and toes, and that the habits of various kinds of monkeys in the use of certain combinations of fingers or toes may be explained satisfactorily by the minute study of the arrangement and several strengths of the various flexor tendons distributed to the fingers or toes.